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ON THE NATURE OF SPACE-TIME IN THE OBSERVATION OF PHYSICAL EVENTS IN SCIENCE[1]

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Summary.—All sciences contain words that define events or aggregates of events from which new properties emerge. There are also words for processes. They require sequential increments of time to be perceived. Systematic relationships exist between the increments of space (meters) and the increments of time (seconds) required to perceive a phenomenon. These relationships suggest that at the largest increment of space, the universe, the processes cannot be perceived. The measurement of femtometer (10^{-15} m) and attometer (10^{-18} m) space by millisecond increments (human perception) allows temporal and spatial increments to be nested into higher order organizations. Whether or not these systematic relationships between the increments of space and time required to perceive a phenomenon and the similarity of fundamental operations relating events and processes that occurs across the sciences imply an externally structured order or simply reflect the fundamental organization of all human brains is discussed.

Ultimately the perception of the organization of every component of the world is determined by the fundamental (axiomatic) microstructures and processes of the human brain. All sciences contain words or symbols, usually nouns, for single events or objects which compose the units or elements that define each discipline. Examples are the atom (chemistry), the cell (biology), the response (psychology), the mineral (geology), the transaction (economics), the quantum (physics), and the group (sociology). There are words for aggregates defined as fields of homogeneous events (or objects) and for aggregates containing qualitatively different events or objects. Examples include cartels for economics, cultural complexes for sociology, metamorphic rocks for geology, gene pools for biology, atoms for physics, galaxies for astronomy, and behaviors for psychology.

An event-object involves a unique aspect of time-space that does not change appreciably from one event-object to another. If the observer's attention is directed towards an increment of space that is too small, then the characteristics of the element are fragmented and cannot be resolved. If the observer's attention is directed towards an increment of space that is too large, the phenomenon is masked by the overinclusion of increments of space for other phenomena. For example, a person in a crowd within a stadium is lost as a percept when he is observed from an increment of 1 μm or a distance of 1 Mm.

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There are also words, usually verbs or gerunds, for processes. Process words within a science refer to phenomena that require the observation of objects or events over successive temporal increments to be perceived. If a process occurs there is a change in the number of elements or in the organizations of the elements composing aggregates that define the phenomenon. For example, learning, aging, economic growth, evolution, diffusion, and entropy are process words for phenomena that are observed when successive temporal units are compared. Words for changes in the organizations of aggregates of events over time are the most difficult to comprehend because they describe properties that can be perceived only from the successive changes in the organization of aggregates rather than changes in the individual elements. Examples from various disciplines might be stages of assimilation-accommodation (developmental psychology), the Bowen sequence (geology), and the carbon-carbon sequence in large stars (astronomy). Graphic representations of these concepts are shown in Fig. 1.

Aggregates of events or objects sometimes generate patterns or gestalts having different properties that are associated with the configuration of the elements and not with the elements themselves. The phrase "energy is nei-

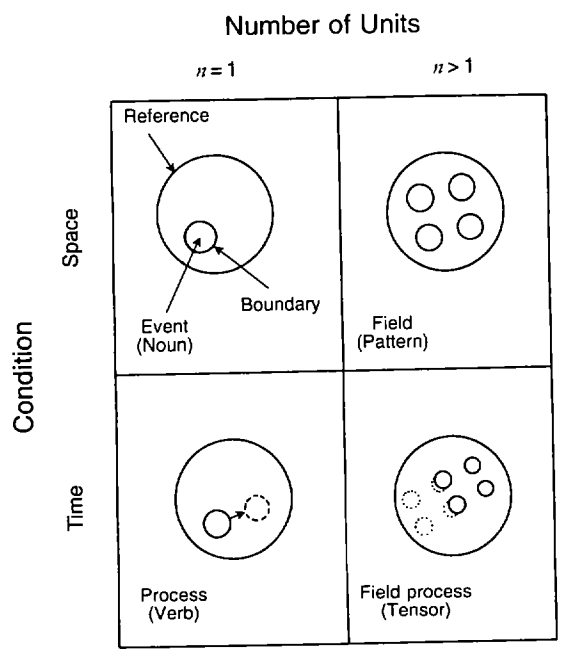

FIG. 1. The four symbolic sets for combinations between elements and combinations of elements (gestalts, fields) and their processes that affect the perception and the conceptualization of phenomena within all sciences

ther created nor destroyed but simply changes form" would be a description of events whose organizations are changed. Many aggregate properties are difficult to deduce from the events constituting the aggregate. One discipline's aggregate is another discipline's element. For example, the aggregate for chemistry (whose unit is the atom) may be the living cell whose gestalt properties are difficult to predict from chemical elements, even when sampling a few essential events from the myriad of chemical elements composing the cell. This same cell, however, is the unit of biology and can be easily identified and described.

Process words within each discipline characterize similar temporal relationships that are observed across various types of scientific discourse. For example, the operation "A affects B and B affects A, without specification of the time required to complete the process," would be Newton's third law in physics, LeChatelier's principle in chemistry, homeostasis in biology, isostasy in geology, stability in psychology, price equilibrium in economics, and the status quo in sociology. The operation "A affects B such that a subset of A remains within the boundary of B after A is no longer proximal in time or space" might be illustrated by electromagnetic induction within physics, genetics within biology, replacement within geology, memory within psychology, collective agreement within economics, and heritage within sociology.

There is a functional relationship between increments of space measured in meters and increments of time measured in seconds that define phenomena and their levels of scientific discourse. To perceive increments of picometer space (atomic reactions) increments of picosecond time are required. To perceive a neuron's action potential from millimetre space (cells), millisecond time is required. To perceive the characteristic of the intrinsic unit of Gigameter (10 9 m) space (inner planetary orbits), gigasecond increments of time are required. Each scientific discipline that has emerged historically has specialized in space and time defined by approximately three orders of magnitude (base 10). Fig. 2 shows a graphic relationship between space and time and the scientific discipline associated with these increments.

The observed organization of the elements of space that are contained within any one temporal increment are fixed and instantaneous within that increment. To discern any potential sequence in these events the increment must be parcelled into several smaller, successive temporal increments. These smaller increments of time define the boundaries for those elements that will be organized into successive perceptual wholes that define a phenomenon. If increments are too small or too large, the event is not perceived. For example, the optimal increment for discerning an action potential is about 1 millisec.

If the increment of observation were 1 billionth of a second the specific organization of spatial characteristics (the spike) that define this neuronal

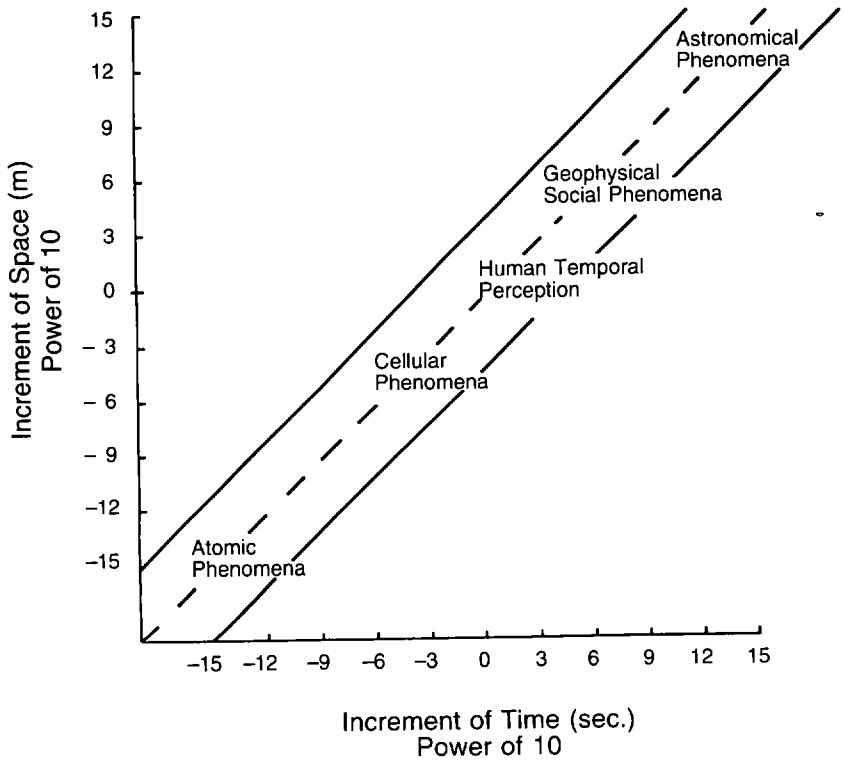

FIG. 2. The apparent relationships between increments of space (in meters) and increments of time (in seconds) that are associated with the perception of phenomena and that define scientific disciplines

property would be obscured because there would be no perceptible changes between each of the one million successive nanosecond (10^{-9} sec.) units that comprise 1 thousandth of a second. If the increment of time was 1 sec., then hundreds of action potentials with different characteristics would be summated, arbitrarily rather than systematically, into vectorial combinations that would preclude the measurement and occlude the observation of any one action potential. Like descriptions by quantum mechanics of subatomic objects and events, only averages of the potentials, with statistical properties of central tendencies and dispersions around the central tendencies, could be achieved.

If the increments of time are too small or too large, then the detection of processes that require observation of successive temporal increments would not occur. If the increment of time selected to observe lunar phase was 1 microsecond or 2.4 Msec. (28 days) rather than 86 ksec. (1 day), there

would be no discernable change in luminosity between successive temporal increments of observation. The process of "phase" would not be discernable. Implicit patterns, such as cycles and periodicities, would not be apparent.

This line of reasoning allows several systematic extrapolations that may be relevant for understanding the limits of human knowledge and the nature of scientific discovery. First, if the increment of time to perceive a phenomenon is coupled with the increment of space and the perception of more than one increment of time is required to perceive processes, then at the largest increment of space, the universe, where there is only one increment of time, there would be no process. From the perspective of this largest temporal increment all object-events and aggregates that have existed, exist, or will exist are fixed instantaneously because there is no observable change within the temporal increment of observation. There would be no discernable process or time for the human observer.

Secondly, smaller increments of space, below an attometer (10^{-18} m) would be discernable because there would always be a temporal series of attometer increments that could be perceived as aggregates or fields to become units at larger increments of space and time. The employment of much larger intervals, e.g., the human sense of the present within the 20-msec. to 200-msec. range, as reference points for a phenomenon that involves attometer or picometer (10^{-12} m) increments would allow processes in attometer or picometer space-time to be organized and reorganized into higher order temporal aggregates. There would be so many degrees of freedom that higher order organizations, dependent upon the critical "mass" or numbers of temporal increments, would emerge. Spatial equivalents to this concept would be the first-, second-, and third-order conformations or shapes of macromolecular structures, the shifts in stacking patterns of DNA from the fundamental helix to its representation within the entire chromosome or the hierarchical organization of specialized behaviours within the history of western civilization. Other phenomena, emergent from the "folding" and the entanglement of smaller intervals of time into larger temporal aggregates would be analogous to first, second, third and n^{th} derivatives in mathematics.

Third, the relationship between space-time (as represented in Fig. 2) should allow the vectorial characteristics of any longitudinal process within a set of object-events to be estimated by one optimal, cross-sectional sampling of a set of elements in one increment of time. For example, if 1% of the human population were sampled randomly in a single instant, the inference of the complete ontogenetic process of any single element (person) could be inferred by seriation or arrangement of the elements of this sample in suc-

cessive approximations of volume and boundary (skin) features. The changes during the life time of the element (birth to old age) could be perceived by a single cross-sectional sampling in space.

Fourth, failures to discern fundamental associations or "causes" between two sets of phenomena, for example, a disease and its etiology, may reflect employment of the less than optimal increments of time and space. Identification of these optimal increments also defines the scientific discourse to which the phenomenon belongs. For example, the relationship between odd luminous phenomena and seismic activity was not apparent when increments of approximately 100 ksec. (1 day) and 100 km, or 30 Msec. (1 year) and 30,000 km were employed. These associations emerged when optimal increments on the order of 2.5 Msec. (1 mo.) and 2,500 km space were employed. They are within the domain of solar-geophysical or large atmospheric phenomena rather than variations in daily human activity.

The source of this close association between the increments of time and space may appear to reflect the existence of an intrinsic physical structure. Although complicated by the application geometry and topological structure, the human brain displays the general properties of and responds predictably from the principles of electromagnetism and chemistry. These similarities of the physiochemical properties of inorganic matter, nonneural organic matter, and neurons would suggest a shared source of physical variance between human perception and the sources of the stimuli that compose the phenomena observed by this perception. From this perspective the mathematical function that, for example, describes and predicts the movement of a projectile is valid because it describes both the perception and the processes external to the perceiver.

The antithetical interpretation is that the relationships between time and space reflect the fundamental constructions or processes within the human brain that organize our perceptions obtained from the most precise electron microscope to the most wideband telescope. From this perspective the function that describes the movement of a projectile through space-time simply reflects the intricacies of the human perceptual system. Mathematical formulas and derivations have been disproportionally successful in describing "natural" phenomena such as gravity or electromagnetism because these formulae have more degrees of freedom and numbers of factorial combinations than nominal scales, such as words and syntax, for articulating the intricacies of the fundamental intracerebral processes that determine the perception of the human brain as a genetic phenomenon over space and time.

The latter interpretation does not necessarily indicate that beliefs and perceptions determine reality. Perception is the organization of the "states of nerves" for those stimuli that achieve access to and are discernable by neuronal activity. For example, the conceptualization of the qualitative proper-

ties of matter as defined by atomic number may be the perceptual organization of stimuli, described as protons, that are actually the numbers of folds in very local space. Until the fundamental organization of brain microstructures and processes that functionally relate these microstructures are changed by experiment or by evolution, there would always be axiomatic processes reflected like fractal solutions at all levels of scientific description. They will produce the commonalities that integrate and provide analogies across the levels of discourse. Their occurrence may be illusionary epiphenomena of the human brain's structure and function and may be determined by the strong dependence of reasoning upon linguistic processing for the categorization of experience and awareness of these experiences rather than representative of the actual sources that produce human perception.

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